Analysing the implication of the EU 20-10-20 targets for world vegetable oil production

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Abstract

The European Commission proposes a minimum of 10 % biofuels in the total transport fuel use by 2020. The new 10% minimum target in 2020 is combined with the existing regulation, which fixes the target at 5.75% in 2010. This paper will in particular investigates how a full implementation of the 20-10-20 targets would affect production and trade of oil plants in the EU and its main trade partners on this commodity markets, particularly Malaysia and Indonesia. The global general equilibrium model GLOBE is used to carry out the policy scenarios and to assess the effects on oil palm plantation area in Malaysia and Indonesia. The results show that the increased EU bio-diesel target will not significantly influence the expansion of palm oil production in Indonesia and Malaysia.

1 Introduction

On 10 January 2007 the European Commission made proposals for a new Energy Policy for Europe. The proposal regards to incorporate a minimum of 10 % biofuels in the total transport fuel use by 2020.The new 10% minimum target in 2020 is combined with the existing regulation, which fixes the target at 5.75% in 2010 (*Directive* 2003/30/EC).
Together with the final targets, a renewable energy roadmap has been proposed:

- a binding 20% target for the overall share of renewable energy in 2020 – the effort to be shared in an appropriate way between Member States;
- a binding 10% target for the share of biofuels in petrol and diesel in each Member State in 2020, to be accompanied by the introduction of a sustainability scheme for biofuels.

These goals are meant to complement the EU energy policy in the aim to increase energy security, to secure domestic agricultural income and to reduce the emission of greenhouse gases.
The need to implement a new policy to enhance biofuels production is motivated by a combination of both international and domestic factors. The unstable situation in the Middle East and the gas conflict between Russia and the Ukraine in earlier 2006, and the subsequent high fossil world oil prices, provides the incentive to explore the possible usage of biofuels to stabilize prices and the supply conditions (USDA, 2007). Similarly, as a consequence of the reform of Common Agriculture Policy (CAP) in 2003 and second wave of a further reform in April 2004, relevant changes have been introduced in the European agriculture economy across the whole rural territory of the EU. Following these reforms, EU farmers are now exploring new market opportunities due to resources shifting from a strong market support into rural development issues.
Due to the differences in production structure and country needs within the EU Member States, the proposal envisages to fix the binding targets for all EU-27 but leaving each Member State (MS) the freedom to determine the best renewable energy mix for its circumstances. Each MS will have to establish National Action Plans for their specific objectives and sectoral targets. The need of common strategy is also reinforced by general evidence that although bioenergy use has grown significantly in absolute terms, national action alone is not sufficient to increase biomass use, due to the faster growth in energy consumption.

The wider objective of the paper is to explore the implications of a binding 10% target for the share of biofuels in petrol and diesel in EU-27 by 2020. In particular, it is of greater interest to investigate how a full implementation of the 20-10-20 targets would affect production and trade of oil plants in the EU and its main trade partners on this commodity markets, particularly Malaysia and Indonesia.
Despite the rapid expansion of EU biofuel production in recent years, the domestic EU demand is growing at even higher rates and is expected to exceed domestic supply. The potential biofuels are mainly ethanol and bio-diesel; the former to replace petrol and the latter to replace diesel. Second generation biofuels are currently being developed, but are not produced at a commercial scale so far.
EU producers of biofuels are mainly devoted to the bio-diesel production; therefore this paper will focus on bio-diesel production, imports, and usage in the EU, only incorporating the replacement of diesel by bio-diesel. Among the various products of which the bio-diesel may originate from (rapeseed oil, waste oils, sunflower oil, palm oil, etc), palm oil appears to be an important factor to focus on, since palm oil is the most important vegetable oil (30% of world vegetable oil production) having the highest per hectare oil yields and generally lowest prices. The two main producing countries of palm oil are Malaysia and Indonesia, accounting for more than 85% of the world palm oil production. Production can be expanded by either increasing yields or/and oilpalm plantation areas. The latter is reason for concern, as the expansion of the production might be done at the expense of rainforest. Policy options fostering the usage of fuels from renewable origin vis-à-vis fossil fuels will be considered and results compared.
The global general equilibrium model GLOBE based on GTAP 6.0 database is used to carry out the policy scenarios and to assess the effects (McDonald et al., 2007). The incorporation of the biofuel sector is provided by adjusting the GTAP 6.0 database introducing a new representing sector and assuming that EU bio-diesel in only produced in EU-27. EU bio-diesel mostly originates from vegetable oil, therefore incoming trade in vegetable oil from Indonesia and Malaysia are assumed to be palm oil. The base scenario simulated the effect of an increase in bio-diesel demand of the transport sector in the EU whilst 4 experiments where carried out.
The paper is organized as followed. Section 2 describes the EU strategy for biofuels and examines the needs behind building a common strategy. Section 3 illustrates the features of EU-27 bio-diesel, and oilseeds and vegetable oil market. Section 4 describes the quantitative analysis. Finally section 5 provides conclusions.

2 EU strategy for Biofuels

The need to implement a European strategy to promote biofuels is motivated by the complexity of this issue which involves different areas of intervention. The main goals of implementing a common policy for biofuels in EU are:

- to increase energy security. The price of a barrel of oil is increasing rapidly affecting the cost of energy and worsening the purchasing power of the European citizens.
- to reduce the emission of greenhouse gases (GHG). The concentration of GHG in the earth's atmosphere is the main determinant of climate change. Rising in temperature and changes in precipitation seasons might affect water resources as well as the agricultural production. Developing an innovative use of renewable energy sources can contribute to create new

perspectives for many European farmers due to the declining available resources in EU agricultural budget.

- Unemployment in EU. The manufacturing sector is currently reluctant to extend the investments to develop new technology able to have a larger use of bio-energy fuels. This constraint the manufacturing sector and prevent the creation of new jobs in EU. Therefore a common strategy is necessary to optimise the industry performance and to favour a better understanding of new opportunities is needed.

Biofuels production in the EU is currently concentrated on a limited number of countries. 80% of the total EU ethanol and bio-diesel production was achieved by only four (Spain, Sweden, Germany, France) and, respectively, three MS (Germany, France, Italy) in 2005. Also in terms of biofuel consumption, there are major differences among MS. By 2005, only Germany and Sweden achieved a market share of 2% or above of total transport fuels (EC, 2006).

Therefore the implementation of a common European strategy in biofuels use should take into consideration those peculiarities. MS have different implementation capacity due to different natural potential that affect their ability to produce and consume biofuels.

Despite the differences in progress among MS, the EU biofuel market is moving from a pioneering state towards a more mature market with the aim of achieving a significant share of total transport fuel volumes, such as the 5.75% target for 2010 set by the biofuels directive and the minimum 10% target for 2020.

Some measures to enhance the biofuel policy are already in place: support on agriculture based on set aside strategy, production facilities, tax reduction, quality standards. But, a cost-efficient instrument for wider market introduction of biofuels is thus needed. For instance, tax exemptions have proven successful so far but at the expense of important net loss of revenues for governments (if fossil fuel prices are not increased at the same time).

The *EU Energy Tax Directive* 2003/96/EC gave additional flexibility to MS for tax exemptions in favour of bioenergy, where this does not over-compensate for cost disadvantages.

The discussion is currently focusing on a switch from tax exemption to obligation (or mixed) systems, reflecting the need for efficient support systems. Therefore, meeting the obligation for fuel suppliers to provide a certain amount of biofuels in the transport fuels may be a solution for larger markets: no losses of revenue for the government will occur as the costs are carried by fuel suppliers and transport users.

Since 2005, twelve MS have switched or will switch from a tax exemption to an obligation scheme (or mixed system) in the very short term. Slovenia introduced an obligation in 2006 while Germany, the Netherlands and Poland changed towards an obligation system by 2007. Other EU MS such as UK, Ireland and Finland are following the same example. Only two major players, namely Spain and Sweden, have not moved to an obligation or mixed system.

One possible alternative might be implementing a system of subsidies but that would be economically expensive and would not meet the requirements of international commitments (WTO issues). In fact, total costs may be lower than for subsidies as a) overcompensation is impossible and b) low-cost options will be used. On the other hand, obligations tend to favour low blend-options, while tax exemptions can also stimulate the use of pure biofuels.

Estimates from FAS (USDA, 2007) point out that bio-diesel demand trend is slightly below the production and recent estimates from the Joint Research Center (JRC) of the European Commission suggest that to meet the 2010 target biofuel consumption should reach 5.9 million tons oil equivalent in 2005, and 18.2 million tons oil equivalent in 2010.

Table 1: Production costs of biofuels at a 5.75% share in 2010

Pathways	Production costs [€/metric tonne]	
Bio-diesel from rapeseed	716	
Bio-ethanol from wheat	649	624*
Bio-ethanol from sugar beet	716	699*
Lignocellulosic ethanol (straw)	955	
Synthetic diesel (farmed wood)	1147	

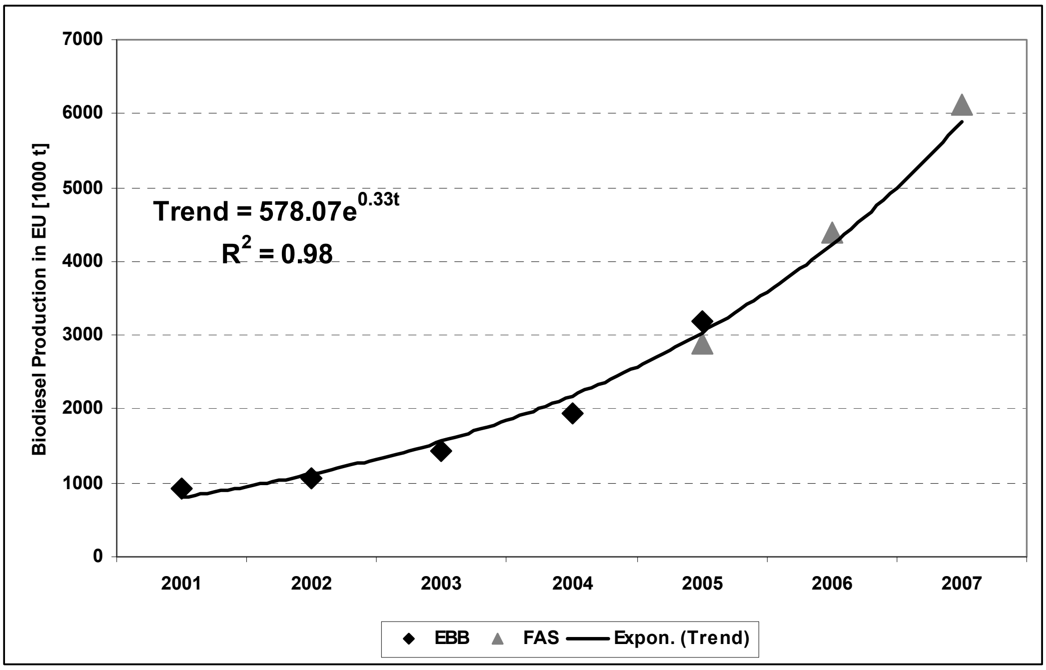
*Note: * Use of DDGS for energy; lignocellulosic ethanol modified to account for recent updates.*
Source: JEC, 2006; modified; TRIAS, 2007 for lignocellulosic ethanol following EC (2007)

First generation biofuels, bio-diesel and bio-ethanol appear to capture the major attention although second generation biofuels are likely to become economically viable. However, the main obstacle to a large usage of biofuels lies in their high production costs compared to conventional fuels.

3 Bio-diesel production in the EU

Figure 1 illustrates the rapid expansion in recent years of EU biofuel production, indicating an average annual increase of 33% from 2001 to 2007. In 2007, EU bio-diesel production is expected to exceed EU demand (USDA, 2007). Given the traditional shortage of bio-diesel in the EU, good profit margins have encouraged many companies to produce not only for domestic demand within a single MS, but also for consumers in other EU MS.

Figure 1: Bio-diesel production in the EU, 2001-2007, in 1000 t



Sources: *2005-2007: Estimations by FAS posts EU25 (USDA, 2007)*
2001-2005: EBB

Consumption of the bio-diesel is expected to continue to increase strongly, however there is a large difference between the uses of bio-diesel in different MS. This is normally associated with the grade of detaxation in the specific MS. In Belgium and the Netherlands the use of bio-diesel for transportation has been almost negligible compared to some other MS such as France, Sweden and Germany. This is because of the limited use of subsidies by the Belgian and Dutch governments.

The EU is the largest producer of bio-diesel world-wide, which is also the most important biofuel in EU. The reason for this large share of bio-diesel is that transportation in EU is mostly diesel based.

Bio-diesel is produced from vegetable and animal oils and fats, mainly originating from oil crops (rapeseed and sunflowers). Oilseeds are crushed to produce vegetable oil and oil cake, a protein rich by-product used for animal feed. Alternatively, other oil types can be used for bio-diesel production, such as used frying oil (which has proven successful in Austria), animal grease, and palm oil. The oil is combined with alcohol (methanol or ethanol) and transformed into bio-diesel thought the process of transesterification, with glycerine as a by-product. During the production process, bio-ethanol can be used to replace methanol. Bio-diesel can either be distributed by road tanker or shipped to refineries or depots to be blended with diesel fuel or sold in its pure form at fuel stations (EC, 2008). This fuel can be used almost as a perfect substitute of traditional diesel and it can be mixed directly to the fossil diesel in any ratio (USDA, 2007).

Advanced bio-diesel (or commonly known as second generation) does not rely on vegetable oil as feedstock, but can make use of virtually all kinds of biomass. This is still in the infant stage of development.

The raw material originates from Europe or from third countries. The main source in the production of bio-diesel is currently rapeseed oil, originating from the crushing of rapeseed mainly produced in the EU.

Bio-diesel imports into the EU are subject to an *ad valorem* duty of 6.5%. However, there is no significant external trade, since the EU is by far the world's biggest producer. Although technical traits are reported to be less favourable than for rapeseed oil, bio-diesel generated from soybean and palm oil can be mixed in low percentages with rapeseed bio-diesel without major problems (EC, 2007). Concerning bio-diesel, an amendment of *standard EN 14214* could facilitate the use of a wider range of vegetable oils, to the extent feasible without significant ill-effects on fuel performance and respecting the sustainability standards (EC, 2007).

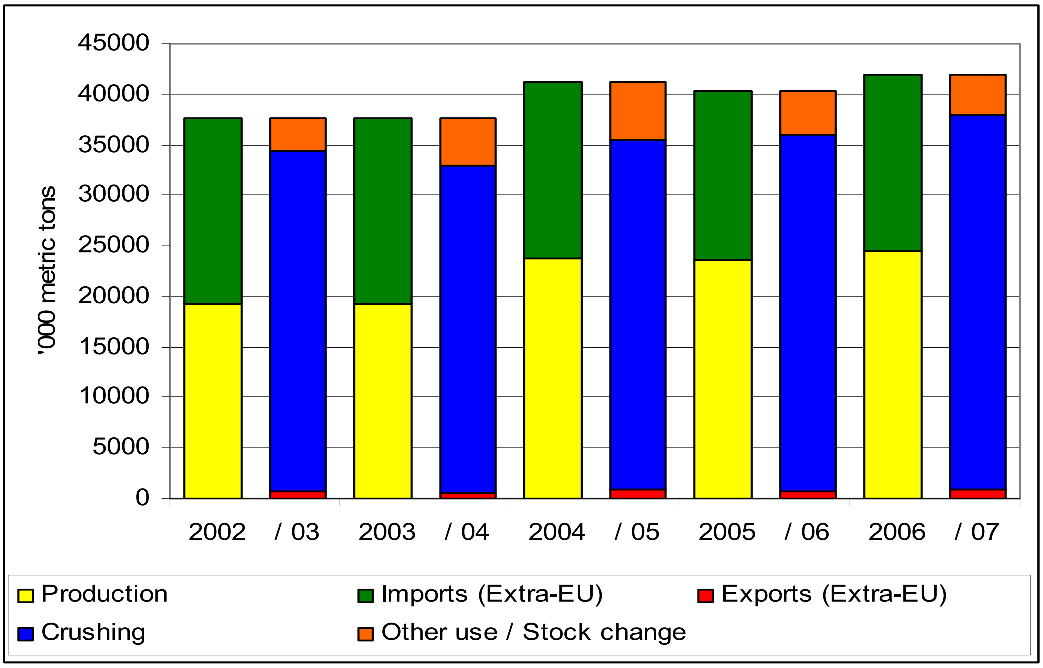
3.1 EU-27 Supply and Use of Oilseeds and Oils

Oilseeds are, following grains, important field crops produced in the EU-27. They are integral part of the crop rotation and face in some instances limitations regarding the time period between crop years. The area development for oilseeds and cereals in the EU-27 can be considered as stable, despite small shifts between different seasons. The reduction of the compulsory set-aside rate to zero starting from this season may add some additional production area, albeit the production of oilseeds for bio-diesel was already allowed on set-aside land for some years and in parts of the EU-27 widely used.

Oilseed production in the EU-27 is dominated by the production of rapeseed with a share of about two-thirds. It is followed by sunflowers which account for a quarter of the EU-27 oilseed production. Soybeans, cottonseed and linseed are the other oilseeds produced to a noticeable extent. The production of olives for olive oil is not considered as oilseed production and will be regarded later. Figure 2 shows the supply and demand balance for all oilseeds adding to the above: groundnut (peanut), copra, palm kernel, sesame seed and castor seed.

Figure 2 shows that a large share of the domestically crushed oilseed are imported these import consist to about 85 % of soybeans. The origin of soybeans entering the EU-27 are Brazil (63 % average of the last four years), USA (24 %), Paraguay (7 %) and Canada (3 %). Other oilseed imports of note are linseed, groundnuts, sunflower and rapeseed, each at about 3 % of overall oilseed imports. Exports are mostly sunflowers. Other use is comprised mainly of direct feed, human consumption, seed use and stock change. This already shows that a large part of in the EU-27 crushed oilseeds do not originate within the EU. Regarding the crushing of oilseeds it should be remembered that oilseeds differ fundamentally in the oil yield. Rapeseed and sunflower have an oil yield exceeding 40 % of the oilseed tonnage, and for soybeans this is only at about 18 %. Soybeans have been mainly planted for the production of soybean meal a very important protein rich feeding ingredient. Due to the increasing difference been soybean meal and oil prices recently the contribution of the oil share to the overall value of soybeans dominates. This has always been the case for sunflowers and rapeseed.

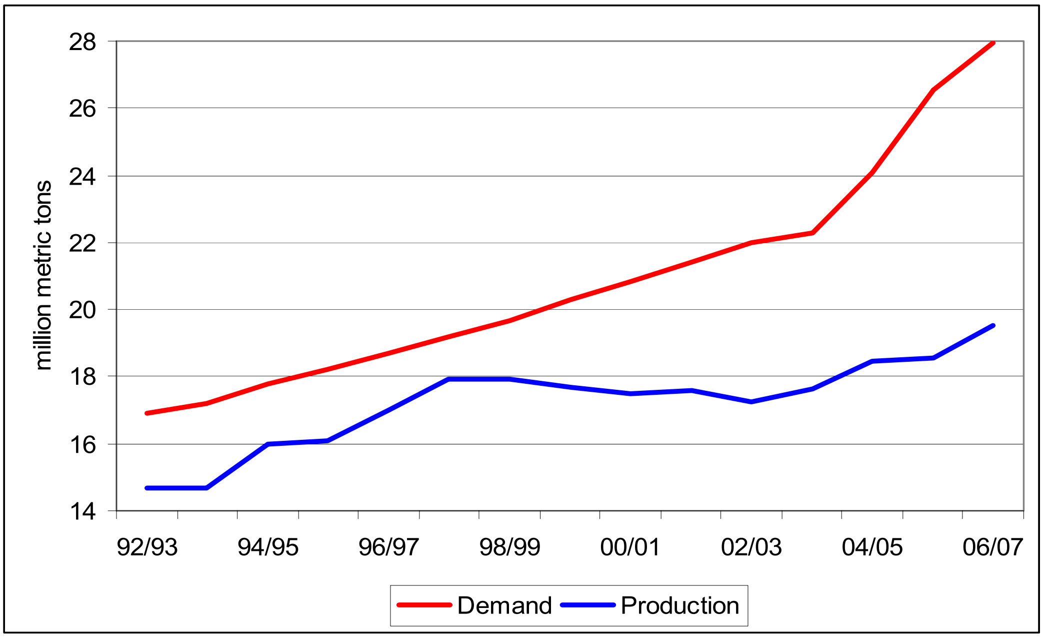
Figure 2: Supply and use of 10 major oilseeds in the EU-27



Source: Oil World, 2007

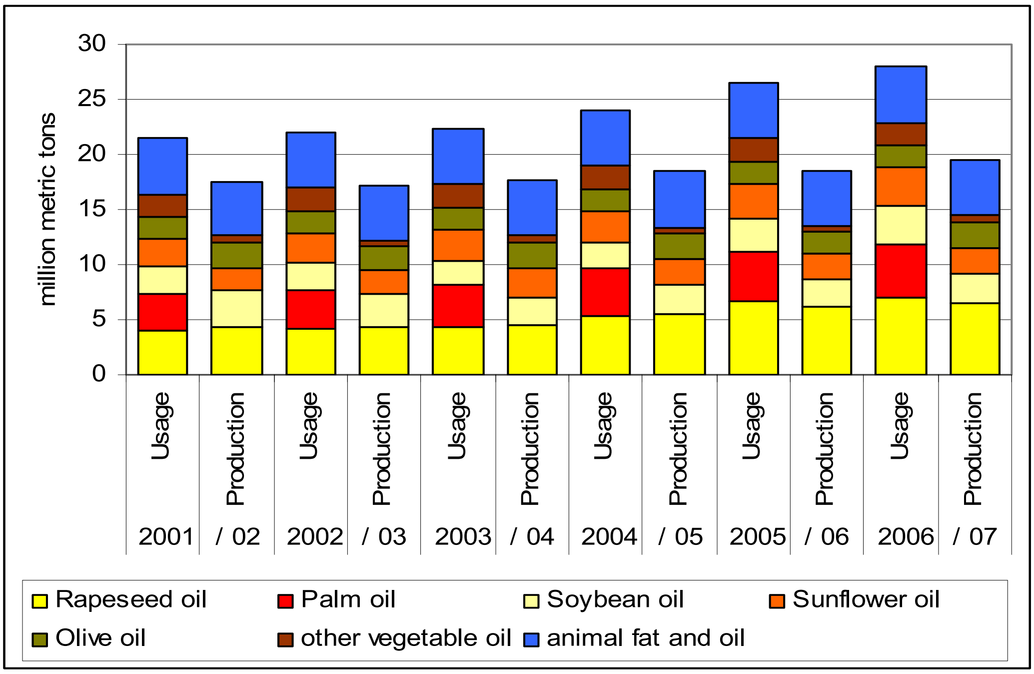
Figure 3 shows the development of vegetable and animal fat and oil production and usage in the EU-27 in the latest fifteen seasons.

Figure 3: EU-27 Overall demand and production of 17 oils and fats (million metric tons)



Source: Oil World, 2007

Figure 4: EU-27 usage and production of 17 oils and fats



Source: Oil World, 2007

As can be seen the gap between domestic production in the EU-27 and demand is increasing in the latest ten seasons. The increasing demand for oils and fats due to bio-diesel production can be depicted by the kink in the demand curve starting in the latest three seasons. To further analyse the situation Figure 4 shows demand and production by type of oils and fats for the latest six seasons.

Most of the included oils are produced from the ten oilseed included before. In addition the animal fats and oils (butter, tallow, lard and fish oil), corn oil, olive oil and palm oil are considered. Especially the later two are of importance in the EU-27. Olive oil is produced mainly in the European part of the Mediterranean region and almost entirely consumed as a high value food oil. Palm oil is not produced in the EU but is following rapeseed the second most important oil used. The world production of palm oil has increased faster than of all other vegetable and animal oils and fats in the recent decades, and it has replaced soybean oil as the most important vegetable oil in the world. At the beginning of the 1990s the share of palm oil has been at about 14% of world production of 17 oils and fats. Palm oil now accounts for about a quarter of the world production of vegetable and animal oils and fats and is most times the price leader (Oilworld, 2007). Indonesia and Malaysia are the world largest palm oil producers, accounting respectively for 40.3 % and 44.7 % of the total palm oil production in 2006. Regarding the trade policies concerning palm oil, there are existing measures in the two main producing countries to regulate exports either via export concessions or via export taxes. On the other hand, the tariffs for palm oil in the EU are rather low ranging between 0 % and 12.8 %. Despite the currently limited use of palm oil in bio-diesel, the EU demand for vegetable oils increases primarily for rapeseed oil but in consequence also for substitutes. With almost 5 million metric tons annually palm oil is the most important vegetable oil imported by the EU-27. This originates almost entirely from Malaysia and Indonesia.

3.2 Description of base line for the simulation

The following will present the starting point of the simulations. They are a combination of the GTAP 6.0 database with information gathered from Oil World, OECD and EBB. The GTAP 6.0 database forms the bases as regards to volumes and in such fixes the base year at 2001 whereas the other sources have been used to create a bio-diesel sector and to add information mainly on quantities. Table 2 and Table 3 show the stylized balance sheet for oilseeds and vegetable oils for the EU-27, and Malaysia and Indonesia, respectively.

Table 2: Stylized balance sheet for oilseeds and vegetable oil in EU-27 (in 1000 metric tonnes, 2001)

		Oilseeds	Vegetable oil
Domestic production	**QXC**	19246	17512
Exports	**QE**	5134	11342
Supply to domestic market	**QD=QXC-QE**	14112	6170
Imports	**QM**	25876	15379
Domestic absorption	**QQ=QD+QM**	39988	21549
Intermediate demand	**QINTD**	36540	10472
Vegetable oil sector		*20354*	
Biodiesel sector			*982*
Other sectors		*16186*	*9490*
Household consumption	**QCD**	3398	11005
Government consumption	**QGD**	18	71
Investment demand (stock changes)	**QINVD**	31	1
Domestic absorption	**QQ=QINTD+QCD+QGD+QINVD**	39988	21549

Source: GTAP 6.0, OilWorld, 2007, EBB, OECD

Table 3: Stylized balance sheet for oilseeds and vegetable oil in Indonesia and Malaysia (in 1000 metric tonnes, 2001)

		Oilseeds	Vegetable oil
Domestic production	**QXC**	8830	24676
Exports	**QE**	86	19591
Supply to domestic market	**QD=QXC-QE**	8744	5085
Imports	**QM**	2292	874
Domestic absorption	**QQ=QD+QM**	11036	5960
Intermediate demand	**QINTD**	7051	4591
Vegetable oil sector		*2767*	
Other sectors		*4284*	*4591*
Household consumption	**QCD**	3984	1368
Government consumption	**QGD**	0	0
Investment demand (stock changes)	**QINVD**	0	0
Domestic absorption	**QQ=QINTD+QCD+QGD+QINVD**	11036	5960

Source: GTAP 6.0, OilWorld, 2007.

The main trade partners for EU-27 on the markets for oilseeds and vegetable oils are shown in Table 4. Indonesia and Malaysia were the main trade partners in 2001 for vegetable oils, accounting together for 44.6 % of the imports from non-EU origins (GTAP 6.0). The aggregate "Rest of the world" accounts for 31.7 %, where particularly Russia and Ukraine are the most relevant countries. The composition of oilseed-trade is completely different as Indonesia and Malaysia account for marginal 0.2 % and the bulk of the imports originates from South America and the NAFTA states (83.1 % together).

Table 4: Origins of EU-27 imports of oilseeds and vegetable oil (at border prices, 2001)

	Oilseeds	**Vegetable oil**	**Oilseeds**	**Vegetable oil**
	mill.USD		% of non-EU Imports	
Indonesia	3	353	0.1	21.5
Malaysia	5	380	0.1	23.1
Rest of ASEAN	2	111	0.1	6.8
India	52	52	1.3	3.2
China	143	17	3.5	1.0
South America	2069	109	50.5	6.7
NAFTA	1333	98	32.6	5.9
Rest of the World	486	521	11.9	31.7

Source: GTAP 6.0

Table 5: Destinations of Indonesian and Malaysian exports of oilseeds and vegetable oil (at border prices, 2001)

	Oilseeds	**Vegetable oil**	**Oilseeds**	**Vegetable oil**
	mill.USD		% of Exports	
European Union (27 MS)	8	733	44.8	17.1
Rest of ASEAN	4	335	24.8	7.8
India	0	919	1.3	21.5
China	0	559	1.2	13.1
South America	0	25	1.2	0.6
NAFTA	1	102	3.3	2.4
Rest of the World	4	1605	23.4	37.5

Source: GTAP 6.0

This composition of import-trade partners gave raise to the concern that increased EU vegetable oil demand will mainly be supplied by Indonesia and Malaysia, which implies the assumption of constant trade shares. However, it is not clear a-priori whether Indonesia and Malaysia would maintain their high share in EU imports when EU demand grows. It is also possible that more vegetable oil is imported from "Rest of the World" or other trade partners, or that the imports of oilseeds from the Americas increases, which would then be processed to vegetable oil by the EU crushing sector. These considerations led to the decision to apply a computable general equilibrium (CGE) model for the analysis of world-wide impacts of changed EU demand for vegetable oil. The general approach is in this context preferable to a partial approach as it is intended to investigate the inter-sectoral effects of a policy that affects primarily the transport sector in the EU but has potential impacts on the agricultural sector in Indonesia and Malaysia. Multi-country CGEs offer an appropriate analytical framework in that respect.

4 Quantitative Analysis of the Increased EU Bio-Diesel Demand

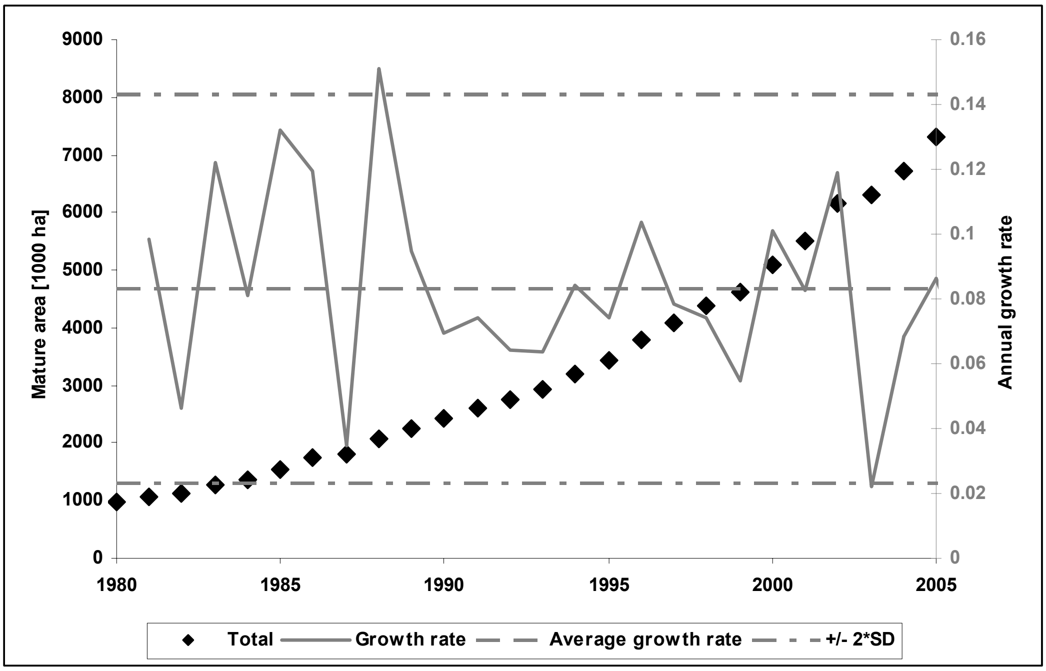
The aim of the study is not to explain increases of oil palm plantations in Indonesia and Malaysia in the past, which potentially came at some cost of rainforest area. Extension of agricultural area may originate from various factors, e.g. growing domestic and international demand for food because of population dynamics. This is beyond the scope of this study. This analysis will only focus on the additional effect of increased EU bio-diesel demand.

The main research question of this study is therefore:

- H0: The increased bio-diesel demand of the EU-27 transport sector will not cause - ceteris paribus - significant increases of oilseed production in Indonesia and Malaysia.
- H1: The increased bio-diesel demand of the transport sector in Europe causes- ceteris paribus - significant increases of oilseed production in Indonesia and Malaysia.

H0 can be rejected in favour of H1 if the results of the CGE analysis indicate a significant increase of the oil palm plantation area in Indonesia and Malaysia.

Figure 5: Growth rate of oil palm plantations in Malaysia and Indonesia



Source: FAOSTAT, own calculation

What is a significant increase? The long-term trend of the oil palm area indicates an average annual growth rate of 8 % with a standard deviation (SD) of 3 percentage points. By using a comparative-static approach, we assume that the base scenario agrees with the trend and that the policy scenarios will cause deviations from the trend. As can be seen from Figure 5, under the assumption of normal distribution of the annual growth rates, we will reject H0 at a 95 % significance level if the model result for the relative change of oil palm area is larger than 6 % (=2*SD).

4.1 The GLOBE model and database

The GLOBE (McDonald *et al.*, 2007) model is a member of the class of multi-country, computable general equilibrium (CGE) models that are descendants of the approach to CGE modelling described by Dervis *et al.*, (1982). The GLOBE model is Social Accounting Matrix (SAM) based that has been calibrated using data derived from the Global Trade Analysis Project's (GTAP) database 6.0 (Dimaranan, 2006), wherein the SAM serves to identify the agents in the economy and provides the database with which the model is calibrated. The SAM also serves an important organisational role since the groups of agents identified in the SAM structure are also used to define sub-matrices of the SAM for which behavioural relationships need to be defined[1]. The implementation of this model, using the GAMS (General Algebraic Modelling System) software, is a direct descendant and extension of the single-country and multi-country CGE models developed in the late 1980s and early 1990s.

Table 6: Applied GLOBE model accounts

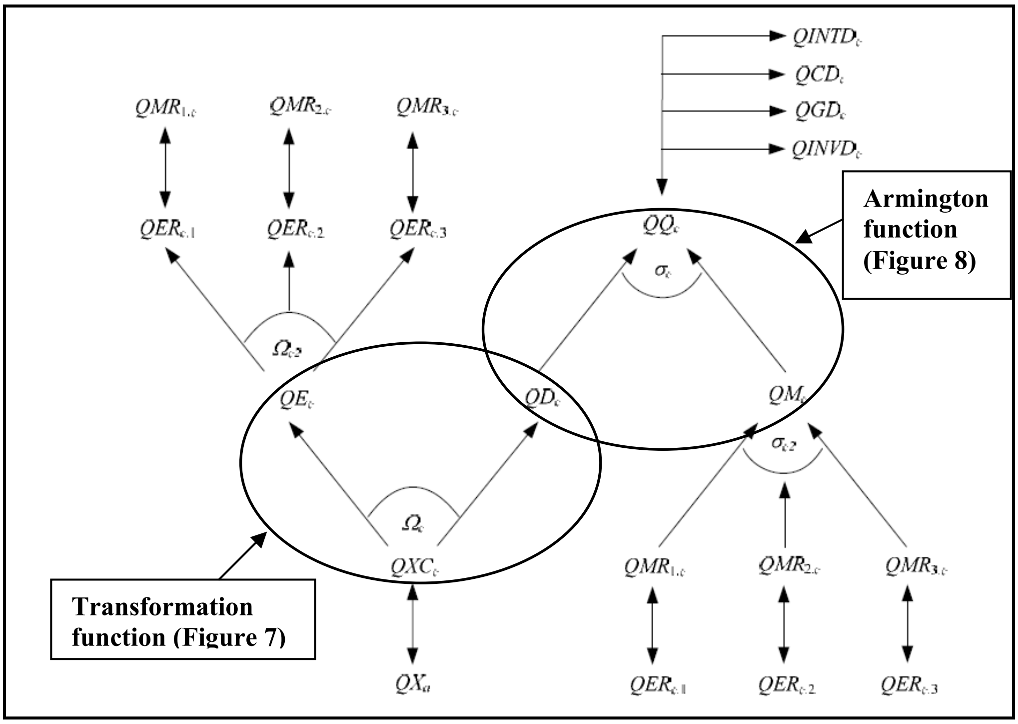
Label	Description	Label	Description
Commodities and Activities		**Factors**	
osd	Oil seeds	land	Land
oplp	Other plant products	UnSkLab	Unskilled labour
anap	Animals and animal products	SkLab	Skilled labour
frs	Forestry	cap	Capital
oprm	Other primary products	natres	Natural resources
col	Coal	**Regions**	
oil	Oil	eu27	European Union (27 Member States)
gas	Gas	idn	Indonesia
vol	Vegetable oils and fats	mys	Malaysia
oprc	Other food,, beverages, and textiles	rasn	Rest of ASEAN
wdpp	Wood and paper	ind	India
p_c_con	Conventional Petroleum coal products	chn	China
p_c_bio	Petroleum products of renewable origin	soam	South America
crp	Chemicals	nafta	NAFTA
indc	Other industries and construction	row	Rest of the World
ely	Electricity		
tran	Transport		
serv	Services		

The here applied aggregation of the GLOBE model consists of 17 commodities and activities, 5 factors and 9 regions (Table 6). A new bio-diesel sector has been introduced by disaggregating the chemical sector. Data for the new bio-diesel sector were mainly generated as "stylized facts" based on technology coefficients from OECD and bio-diesel production data from EBB. Consumption of bio-diesel was generated based on the shares of fuel usage. This sector is only used in the EU and there is

[1] As such the modelling approach has been influenced by Pyatt's "SAM Approach to Modeling" (PYATT, 1987).

no trade assumed. The GLOBE model connects production and consumption in the model regions as illustrated in Figure 6.

Figure 6: Quantity system of a representative region in the GLOBE model



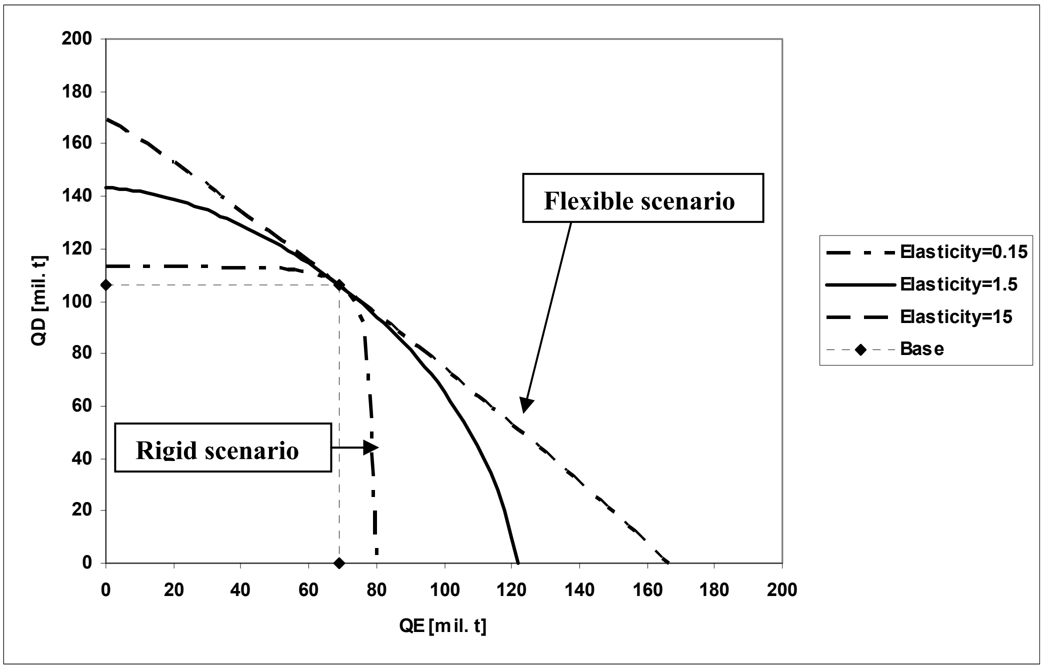
Source: McDonald et al. 2007

4.2 Baseline and scenarios

The scenarios with GLOBE simulate the effect of increased bio-diesel demand of the transport sector in the EU. The policy target of 10 % share of bio-fuels is here interpreted as referring to bio-diesel only and is implemented by changing the intermediate demand coefficients (ioqint) of the transport sector, thus assuming that the politically desired technology change has taken place.

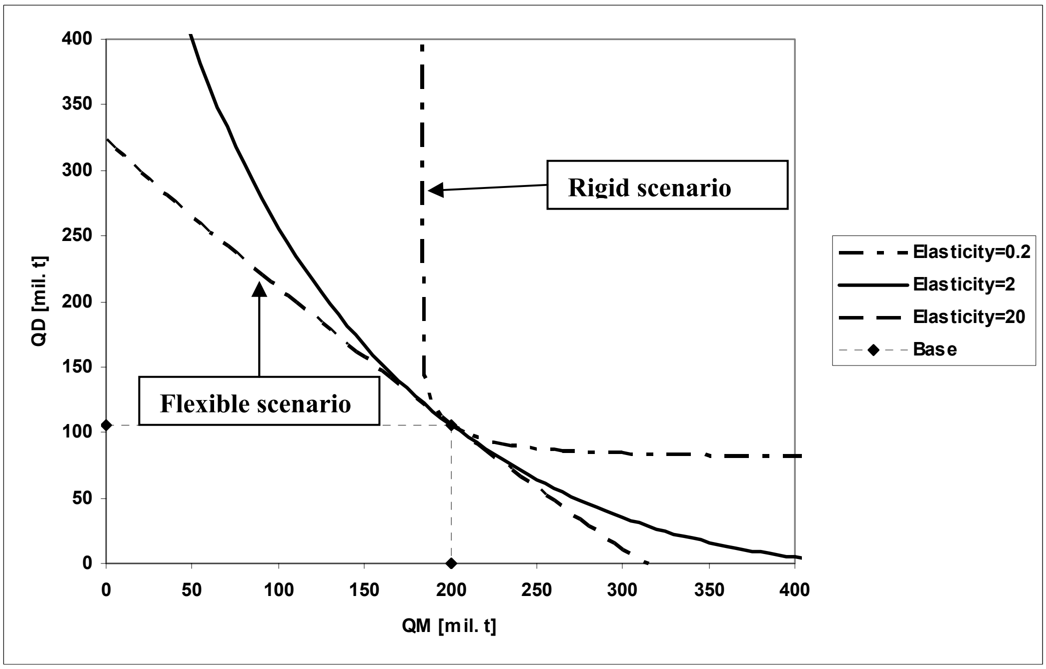
In the base situation, the ratio between conventional fuel usage to bio-diesel usage in the transport sector is approximately 99:1 (GTAP 6.0, EBB, own calculations). The coefficient matrix ioqint is adjusted such that this ratio is now 90:10, which implies that 10 % of the fuel demand now comes from renewable resources. This setting is a severe simplification since bio-ethanol and other alternatives to bio-diesel are not considered. The model settings consequently can be viewed as an extreme scenario, and real-world effects of the increased demand for biofuels in general will be distributed across the different potential sources.

Figure 7: Effects of alternative elasticities of transformation on the market for vegetable oils in Indonesia and Malaysia



Source: Oil World (2007), own presentation

Figure 8: Effects of alternative Armington elasticities on the EU-27 vegetable oil market



Source: Oil World (2007), own presentation

Experiments:

The simulations carried out reflect these differences in market behavior and are implemented as follows:

Simulation 1: (Sim01)

- Adjustment of input-demand coefficient (ioqint) of the transport sector in EU-27 such that the ratio of bio-diesel to conventional fuels equals a 10:90 ratio (instead of 1:99 in the base)
- Default settings for Armington elasticities
- Default settings for transformation elasticies

Simulation 2: (Sim02)

- Adjustment of input-demand coefficient (ioqint) of the transport sector in EU-27 such that the ratio of bio-diesel to conventional fuels equals a 10:90 ratio (instead of 1:99 in the base)
- Increase of Armington elasticities on the oilseed and vegetable oil markets in EU-27 by the factor 10 (flexible market in EU-27)
- Decrease of transformation elasticities on the oilseed and vegetable oil markets in Indonesia and Malaysia by the factor 10 (rigid market in Indonesia and Malaysia

Simulation 3: (Sim03)

- Adjustment of input-demand coefficient (ioqint) of the transport sector in EU-27 such that the ratio of bio-diesel to conventional fuels equals a 10:90 ratio (instead of 1:99 in the base)
- Decrease of Armington elasticities on the oilseed and vegetable oil markets in EU-27 by the factor 10 (rigid market in EU-27)
- Increase of transformation elasticities on the oilseed and vegetable oil markets in Indonesia and Malaysia by the factor 10 (flexible market in Indonesia and Malaysia

Simulation 4: (Sim04)

- Adjustment of input-demand coefficient (ioqint) of the transport sector in EU27 such that the ratio of bio-diesel to conventional fuels equals a 10:90 ratio (instead of 1:99 in the base)
- Increase of Armington elasticities on the oilseed and vegetable oil markets in EU27 by the factor 10 (flexible market in EU-27)
- Increase of transformation elasticities on the oilseed and vegetable oil markets in Indonesia and Malaysia by the factor 10 (flexible market in Indonesia and Malaysia

4.3 Main results

All simulations have in common that they reflect a situation in which the European transport sector has changed its technology such that it always satisfied 10 % of its demand for energy bearers by using bio-diesel. We have not considered the cases of second-generation biofuels or bio-ethanol, so the main scenario can be considered as rather simplistic. We do not aim at a complete prediction of the European economy in case of policy changes but rather want to answer the single question whether increased bio-diesel demand in EU-27 will have a significant influence on the oil palm areas in Indonesia and Malaysia. Against this background, alternative biofuels can be neglected as a higher share of those in the energy mix of EU-27's transport sector will decrease the share of bio-diesel and thus mitigate the effects on vegetable oil trade and production. We are more interested in an extreme scenario.

The main scenario (Sim01) is then repeated under alternative settings for the relevant markets in EU-27 and Indonesia and Malaysia. The results do not differ remarkably across the alternative settings for the markets (less then one percentage point in all cases), so that we will refer to the basic setting (Sim01) in the following explanations.

Effects on domestic demand, production, and imports of EU-27

The immediate effect of the realization of the bio-fuel target as implemented in the simulation settings is a tremendous increase of the demand for vegetable oil from the newly introduced biodiesel sector by 828.13 % (Table 7).

Table 7: Results: Vegetable oil in EU-27 (in % change from base)

		Sim01	Sim02	Sim03	Sim04
		%-change from base			
Domestic production	**QXC**	6.78	6.83	6.75	6.82
Supply to domestic market	**QD**	6.86	6.94	6.81	6.92
Imports	**QM**	4.47	3.76	4.93	4.05
Domestic absorption	**QQ**	6.81	6.82	6.81	6.82
Intermediate demand	**QINTD**	**14.12**	**14.13**	**14.12**	**14.13**
from biodiesel sector		***828.13***	***828.15***	***828.12***	***828.16***
from other sectors		*1.29*	*1.30*	*1.28*	*1.29*
Household consumption	**QCD**	-0.10	-0.08	-0.11	-0.08
Government consumption	**QGD**	-0.05	-0.05	-0.05	-0.05

Source: Own results

As this component of total intermediate demand for vegetable oil has only a comparative small share in the base situation, the overall increase of intermediate demand (QINTD) for vegetable oil ranges slightly above 14 %. As a consequence, the domestic prices for vegetable oil rise, thus causing lower final demand from domestic institutions (household and government). The net effect on total domestic absorption (QQ) is a 6.81 % increase, which is satisfied by higher domestic production (QXC +6.78 %) and imports (QM +4.47 %). Higher levels of domestic production of vegetable oil foster the intermediate demand for oilseeds, which in turn is satisfied by increased domestic production and imports (QXC +4.17 %, QM +2.85 %; Table 8). The import demand for vegetable oil and oilseeds is then met at comparatively stable shares of the trade partners, among which Indonesia and Malaysia maintain their share of approximately 45 % in all scenarios (44.6 % in the base, 44.8 % in Sim04). This result may give raise to the question of plausibility as it could as well be the case that the trade share of Indonesia and Malaysia in the vegetable oil imports of EU-27 may increase because of the specific demand for palmoil for bio-diesel production. On the other hand, that it is more likely that the increased demand for palmoil will have immediate price effects which will then cause a higher attractiveness of other types of vegetable oil. These effects may compensate each other, such that the trade-share in the aggregate vegetable oil sector remains unchanged. We consider this line of thought as more plausible than the assumption that the vegetable oil demand of EU-27 will be satisfied by only one trade partner.

Table 8: Results: Oilseeds in EU-27 (in % change from base)

		Sim01	Sim02	Sim03	Sim04
			%-change from base		
Domestic production	**QXC**	4.17	4.84	3.81	4.83
Supply to domestic market	**QD**	4.19	5.04	3.73	5.03
Imports	**QM**	2.85	2.01	3.30	2.01
Domestic absorption	**QQ**	3.70	3.77	3.66	3.77
Intermediate demand	**QINTD**	4.10	4.17	4.06	4.16
Vegetable oil sector		***6.81***	***6.87***	***6.78***	***6.85***
Other sectors		*0.68*	*0.77*	*0.63*	*0.76*
Household consumption	**QCD**	-0.49	-0.38	-0.55	-0.38
Government consumption	**QGD**	-0.05	-0.05	-0.05	-0.05

Source: Own results

Effects on production and exports of Indonesia and Malaysia

The effects of the technology change on the markets for oilseeds and vegetable oil within the EU-27 trigger also changes in Indonesia and Malaysia: Exports to EU-27 increase – depending on the settings for the markets – between 3.61 % and 5.28 % (table 9), but the overall increase of the exports is much lower (between 0.57 % and 1.14 % in the case of vegetable oil, Table 9; 0.18 % to 1.10 % for oilseeds, table 10) as EU-27 is only the destination for 17.1 % of the vegetable oil exports.

Table 9: Results: Vegetable oil Indonesia and Malaysia (in % change from base)

		Sim01	Sim02	Sim03	Sim04
			%-change from base		
Domestic production	**QXC**	0.63	0.48	0.74	0.59
Exports	**QE**	0.88	0.57	1.14	0.91
to EU27		*4.56*	*3.61*	*5.28*	*4.27*
Supply to domestic market	**QD**	0.44	0.41	0.45	0.36
Imports	**QM**	0.51	0.23	0.68	0.57
Domestic absorption	**QQ**	0.45	0.40	0.46	0.37
Intermediate demand	**QINTD**	0.53	0.44	0.58	0.46
Household consumption	**QCD**	0.18	0.26	0.06	0.05

Source: Own results

Table 10: Results: Oilseeds Indonesia and Malaysia (in % change from base)

		Sim01	Sim02	Sim03	Sim04
		%-change from base			
Domestic production	**QXC**	0.18	0.09	0.26	0.20
Exports	**QE**	0.54	0.18	1.10	0.66
Supply to domestic market	**QD**	0.17	0.09	0.23	0.18
Imports	**QM**	2.01	2.52	1.75	2.57
Domestic absorption	**QQ**	0.18	0.11	0.25	0.20
Intermediate demand	**QINTD**	0.28	0.17	0.39	0.31
Vegetable oil sector		*0.54*	*0.33*	*0.75*	*0.60*
Other sectors		*0.11*	*0.07*	*0.15*	*0.12*
Household consumption	**QCD**	0.01	0.01	0.01	0.00
Oilseed area		**0.16**	**0.08**	**0.25**	**0.18**
Significant increase (95% level)		**6.00**	**6.00**	**6.00**	**6.00**

Source: Own results

Domestic production of oilseeds and vegetable oil do not increase substantially and therefore, the oil palm area grows between 0.08 % and 0.25 %, depending on the scenario. In all cases, the simulated increases are smaller than the standard error of the annual growth rate (3 percentage points, Figure 5) and the test statistic for a significant increase caused by higher demand of EU-27 (twice the standard error) was not exceeded. Therefore, we can not reject H0 on a 95 % significance level: The used model and its underlying dataset do not provide significant evidence that the implementation of the 10 %-target on the transport sector will cause a substantial increase of oil palm plantation area. This is not to say that there would be no further expansion of the plantation areas, which may continue to grow at the observed annual rate of 8 %, but the role of EU-27's demand for bio-diesel appears not to be a significant driving factor.

5 Conclusions

The main result from the study presented here is, that the hypothesis that higher bio-diesel demand in EU-27 will cause significant expansion of oil palm plantations in Indonesia and Malaysia could not be supported by the model analysis. It should be emphasized that this result does not mean that no further increase of the plantation areas at the expense of rainforest area is expected. This may continue to follow the long-term trend as depicted in Figure 6 (8 % annual growth rate), but changes of European demand patterns for oilseeds and vegetable oils do not appear to trigger substantial changes of the trend. It has to be noted that the obtained results rely on the validity of the GTAP database, which showed some deviations from the other sources we used, particularly the Oil World datasets. Testing the results presented in this study by repeating the simulations based on another dataset will be an important step to substantiate the outcomes of this study.

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